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Materials and Manufacturing: Re-design component

The component that I have chosen to re-design is the dual suspension mountain bike frame.

This frame will then be re-designed into a light endurance motorbike frame.

Mountain bikes are used for a range of purposes. Unlike road bikes, mountain bikes are “tailor made” for a specific terrain or even riding style (The BikeExchange Team, 2016). Some mountain bikes have generous suspension in the front and back. This is called dual suspension or full suspension. This form of suspension will be used to deal with rough trails and allow more suspension movement. Dual suspension also helps absorb impact from trails, giving the rider more traction and comfort whilst using the bike. This suspension also helps keep the wheels of the bike on the ground especially whilst on a rougher bike trail.

Aluminium is commonly used as the material for mountain bike frames (The BikeExchange Team, 2016). With similar properties to carbon fibre, aluminium is a light, strong and stiff material (The REI co-op) that is easy to work with and is a cheaper option compared to carbon fibre. Bikes made from aluminium can transfer power much quicker due to its stiffness and the thickness of the tubes that are used to manufacture them. Strength is added to the frame by adding ‘butting’ (The BikeExchange Team, 2016). By doing this, the frame will become thicker in places where strength is needed – such as the welded ends – but still retain its lightness.

As the name suggests, mountain bikes are typically used on mountain trails and the like. In general, they are expected to last for years whilst being used in extremely rough terrain such as mud, gravel and rocky surfaces. As a result of this, it is important that the bike is machined manufactured to a high standard to withstand such an extreme working environment.

Unlike a mountain bike, a light endurance motorbike is used for long distance and cross-country races or time trials. They are an off-road motorcycle and are built to hold up under extreme conditions (Nat Berman, 2018).

As a result of this, the re-design of the dual suspension mountain bike frame will have to be able to withstand a much rougher terrain at much higher racing speed. The light endurance motorbike frame will have to be able to take the force of the cross-country environment without getting damaged easily.

When designing a light endurance motorbike frame, there are things that must be considered. Firstly, unlike the mountain bike, the re-design must include a space for the engine, exhaust and so on. This will also affect the seating position of the rider. As this type of motorbike is used for off-road endurance racing, the frame will have to be stronger than that of a mountain bike and be able to withstand a high-speed crash, without getting damaged beyond use and protect components of the motorbike in the event of a crash.

In addition to this, the frame will have to be relatively light in order to not compromise the agility and fluidity of the rider on the bike. Endurance bikes are known for riders “to move in and out of trees and brush groves that are often a tight fit” (Nat Berman, 2018), therefore, the bike must be narrow enough to be able to proceed through a trail without difficulty.

Similar to mountain bike frames, motorcycle frames are usually made from welded aluminium or carbon fibre for a more expensive custom frame (Diseno-art.com, 2014). Using aluminium will create a light frame that will retain its strength whilst using it. However, for the re-design I have decided to use “high-tech, lightweight chrome-moly steel” (KTM, 2019) as a light endurance motor bike frame is used on rough terrain, it must be able to soak up the impact of an uneven track or surface.

The properties of lightweight chrome-moly steel include “creep strength, hardenability, wear resistance, rigidity, good impact resistance (and) ease of fabrication” (AZO Materials, 2017)

The lightweight chrome-moly steel will ensure that the bike will have easy handling with precision whilst going around corners of tracks. As the material is considered to have high torsional rigidity and a low longitudinal stiffness, the bike will have a better energy absorption that will be created by the suspension whilst the bike is being ridden. This will result in better comfort and less fatigue for the rider (KTM, 2019).

The frame of the light endurance motorbike is made by casting the lightweight chrome-moly steel into moulds. This will create long metal tubes. The tubes will then be butted to create the hole that would travel through the whole tube. This would make the bike frame lighter to use and, therefore, faster to ride. The tubes would then be straightened as the butting process would have warped the tubes slightly (How it's made 2016).

The tubes will then go through a heating process that will soften the metal slightly as the processes above would have hardened the material, therefore, making it more difficult to work with.

The tubes will then be cut to the correct length for the frame. This would be done by using jigs to ensure that each tube is the correct length or angle for each part of the frame. Using jigs is very important to make sure there is constancy in each part of the frame. This is known as quality control.

After the tubes have been cut, they will then be bored. This means that extra material will be added to parts of the tube that will need that extra strength to ensure that material can withstand hard hits. Butting will usually take place at parts of the material that will likely to be welded together. Lightweight chrome-moly steel is not as easily weldable compared to other materials. It requires "pre and post weld heat treatment" that will prevent cold cracking (ProFormance Metals). It can be welded by applying heat to the stress related areas of the tubes.

Once the tubes have been welded to create the motorbike frame, it will then be bored. Boring ensures that the holes that are needed for fastenings to attach the engine and so on, will be smooth and easy to insert (How it's Made, 2016).

The final main process to making the lightweight endurance motorbike frame is to heat treat the whole frame. This will soften the material to its original state before all the manufacturing processes took place. Thus, ensuring that all the original properties of the material are being fully utilized (How it's Made, 2016). The frame will then be cleaned with a cleaning solution to make sure that the surface is clean before adding any finishes such as paint or graphics.

The fasteners that are on the frame are made from aluminium. They are used to either connect certain parts of the frame that cannot be welded, or to attach the engine and other components to the frame. Fastenings such as nuts and bolts are usually made by using a manufacturing process called cold forming or cold extrusion (Wuerth Industrie). Cold forming is usually done using "multistage processes" that includes processes such as pressure forging, cold extrusion and reducing. When machining fasteners the process that is usually used is turning.

The threads that are on fasteners are typically machined by a process known as rolling. The aluminium rods are rolled between two rolling dies. One of these dies are fixed in position, whilst the other is running. As the rod travels through the dies, the thread is created. Once

the thread has been created, the material will then be hardened and tempered (Wuerth Industrie).

Once the fasteners have been manufactured, they will then be given the same finish as the lightweight chrome-moly steel that was used for the main body of the light endurance motorbike frame.

Below is the bill of materials for the materials that have been discussed above for the light endurance motorbike frame:

Component	Number of Components	Materials	Manufacturing Process
Light endurance motorbike frame	1	Lightweight chrome-moly steel, Steel,	Casting, Cooled, Butted, Straightened, Tack welding, Final welding, Boring, Heat treated, Painted
Fasteners		Aluminium rods	Cold forming, Turning, Rolled

Lightweight chrome-moly steel is more expensive than a material such as aluminium. However, it is three times stronger than a material such as aluminium. If the light endurance motorbike frame was to be made from aluminium, then the frame would have to be much bigger in size to get the same strength of one that was made from light chrome-moly steel. As a result of this, a frame made from aluminium would use more material compared to one

of light chrome-moly steel. Therefore, the frame would be more expensive to manufacture. Thus, making light chrome-moly steel an obvious choice (Voestalpine AG, 2017).

In addition to this, the use of light chrome-moly steel would also benefit the rider of the bike. Considering that there would be less material used for the frame, the motorbike would be lighter. Therefore, creating an easier bike for the rider to manoeuvre around a cross-country trail.

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Dual suspension mountain bike frame



Bill of Materials

Component: 1 Bike Frame.

Materials: Aluminium, Steel.

***Manufacturing Process: Aluminium tubes - cut using jigs,
Welded - tack welding - final welding,
Heat treated,
Bored,
Painted.***

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Dual suspension mountain bike frame VS Light endurance motorbike frame



- 1. Frame has increased in size to allow room for engine.***
- 2. Change of material: Aluminium > Lightweight chrome-moly steel.***
- 3. Frame is thicker than the aluminium frame because of the higher speed the bike would travel.***